Bayer Polymers: Plant Identifies Numerous Projects Following Plant-Wide Energy-Efficiency Assessment

Benefits

- Identified $1.4 million in annual savings from energy-efficiency improvements
- Found ways to reduce use of fossil fuel (by 236,000 MMBtu per year)
- Identified methods to reduce production of NO_x and CO_2
- Found ways to save an estimated 6.3 million kWh of electricity annually
- Can achieve payback ranging from 0.5 to 32 months, depending on the project

Application

The Bayer Corporation's plant-wide energy assessment focused on the technical and economic evaluation of existing utility systems and identified areas that could benefit from equipment modifications and upgrades. Such areas included boiler, steam, compressor, and motor-driven pump systems. Upgrades in these systems, and their accompanying energy and cost savings, can be replicated in other industrial plants.

Summary

The Bayer Corporation undertook a plant-wide energy-efficiency assessment of its New Martinsville, West Virginia, plant in the spring of 2001. The assessment objectives were to identify energy saving projects in Bayer's utilities area, including boilers and associated steam systems, compressor systems, and electrical motor-driven pump systems. The project evaluation process was unique in that the company has obtained very favorable rates for electricity, even by West Virginia's very favorable standards in the industrial sector. Even so, the company found strong economic justification for several projects that would reduce either electricity consumption or fossil fuel consumption.

The projects, when complete, will reduce the amount of fossil fuel that is burned and leaked, saving the company an estimated 236,000 million British thermal units (MMBtu) or an estimated $1.16 million annually based on an average cost of fossil fuel. Certain other projects will save the company 6.3 million kilowatt-hours (kWh) of electrical energy. All of the projects are potentially applicable to other chemical manufacturing facilities and most of the projects have potential applicability to other industries.

DOE-Industry Partnership

The U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) cosponsored the assessment through a competitive process. DOE promotes plant-wide energy-efficiency assessments that will lead to improvements in industrial energy efficiency, productivity, and global competitiveness, while reducing waste and environmental emissions. In this case, DOE contributed $87,000 of the total $181,000.

Company Background

The Bayer Corporation is the largest subsidiary in the Bayer Group, with some 23,200 employees working at more than 50 locations in the United States. Bayer Polymers[1] New Martinsville, West Virginia plant has 16 production units and employs 950 workers. The plant produces more than 1.2 billion pounds of chemical intermediates, polyurethane materials, food-grade hydrochloric acid, and iron-oxide pigments each year. These materials are used in cars, appliances, furniture, home construction, steel manufacturing, food preparation, and many consumer products. The plant infuses $130 million into the local economy.

The Bayer Group operates about 350 companies that employ 117,000 workers throughout the world. The headquarters of the Bayer Group is in Leverkusen, Germany. Its business activities are concentrated in Europe, North America, and the Far East.

[1] Company's name was Bayer Corporation at the time of the assessment. (Company statistics also apply to that time.)

Assessment Approach

The plant-wide energy-efficiency assessment focused on the technical and economic evaluations of existing energy systems in the plant utilities that could benefit from equipment modifications, leak reduction, heat recovery, improved control systems, additional insulation, and burner adjustments. The systems that were evaluated included those using significant quantities of natural gas (NG), electrical power, and chemically treated water. Reducing production of nitrogen oxides (NO_x) and carbon dioxide (CO_2) was also a high priority.

The assessment team consisted of the Bayer Corporation's director of utilities and maintenance, the manager of utilities, and a member of process engineering. The review was a joint effort of these management experts and an assessment team from West Virginia University (WVU). The Bayer team prepared a list of energy-efficiency concerns and discussed them with the WVU team. During the summer of 2001, the WVU team made regular site visits to collect necessary energy-use and management data at the plant. The assessment focused on boiler system operation, insulation needs, steam leaks, steam system condensate, compressed air, and motor performance.

The WVU team then conducted a detailed analysis of the data, which focused on component-level specifics (heat losses in pipes, flanges, tanks, cooling towers, and valve spool pieces specific to each boiler). The WVU team issued a report in July 2002 describing the analysis and several proposed projects. The utility management staff saw high priority items (steam and compressed gas leaks) with less than 1-month payback and acted on those immediately. The Bayer team assigned the ultrasonic leak survey to Colt Atlantic. Because the steam leaks were visible and easy to locate, Colt Atlantic's efforts focused on locating and correcting NG, compressed air, and nitrogen leaks.

The plant is composed of various departments that operate as modular business units. Each department pays a set rate for the utilities it requires for production. To implement some projects, it is expected that innovations and incentives will be required. For instance, to increase condensate return to the boilers from the departments, it may first be necessary to establish a dollar-per-pound reimbursement for returned condensate (see Project 2 below).

Results

To ensure that all project goals were met, the Bayer team wanted to 1) identify significant energy savings and attractive payback and 2) proceed based on environmental criteria. The company is very interested in reducing the production of NO_x and CO_2 which, as seen below, is frequently an outcome that accompanies energy conservation projects.

The Bayer plant operates with a 25-megawatt electric load and is the second largest user of NG in the state. The total annual cost for imported utilities is more than $15 million. The Bayer team recognized that even a small improvement in the efficiency of the plant's main energy consumers, boilers and large pumps, could create a significant savings.

The plant-wide energy-efficiency assessment identified several attractive projects based on the above criteria. Table 1 provides a list of five projects that Bayer plans to submit internally for implementation. For each project, the table indicates expected project costs, estimated annual savings, and expected payback periods. The greatest annual energy savings will come from boiler burner replacements, increased condensate return, and a portion of Project 5 that reduces the number of NG leaks (discussed below).

Projects Identified

The following discussion provides details of the selected energy-efficiency projects developed during the plant-wide assessment. Because of the similar basic utility processes used in chemical plants, all of

Project	Project Cost ($)	Annual Savings ($)	Payback (mo)
1. Burner replacement with an efficient, low-NO_x design	390,000	363,000	13
2. Expanded condensate return	100,000	373,000	3
3. Installation of variable speed drives (VSDs) on cooling tower pumps	264,000	153,000	21
4. Compressed air system optimization	165,000	61,800	32
5. Four energy-saving projects costing $10K or less	18,200	477,000	0.5
Totals	**937,200**	**1,427,800**	

Table 1. Estimated Project Cost, Savings, and Payback for Bayer Corporation

the projects are highly applicable to other chemical plants. In addition, these projects seek to improve common utility systems (boilers, steam, compressed air, and motors) so the projects are very replicable in many other industries.

Project 1—Burner replacement

The plant-wide evaluation of boiler operations found that the NG-fired burners in four boilers and combined NG- and hydrogen-fired burners in two boilers were not the newer high-efficiency designs. The new designs produce a controlled, slow-burning, low-temperature flame that produces less NO_x and CO_2. Vendors indicated that a 2% improvement in efficiency could be realized by switching to a newer burner. Replacing the six burners would yield an energy savings of 74,800 MMBtu per year (MMBtu/yr) and an 8.46-million-pound annual reduction of CO_2.

Project 2—Condensate return

The WVU analysis clearly showed that by increasing the amount of condensate returned to the boilers, the company would pay less for makeup water, would save NG in the initial heating of the makeup water, and would also save the expenses of chemical and treatment costs for the makeup water. Furthermore, there would be a small savings from discharging less water into the sewer system. Increasing the condensate return may require separators or filters to remove contaminants (such as rust and oil) and additional piping. Increasing the condensate return from the present 30% (30,000 pounds per hour [lb/hr]) to 75% (75,000 lb/hr) will produce an overall energy savings of 66,600 MMBtu/yr and a 7.53-million-pound annual reduction of CO_2.

Project 3—Use of VSDs on pumps

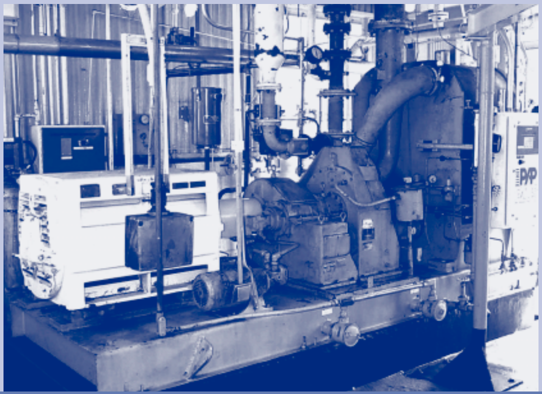
The utilities department at the Bayer plant provides cooling tower water to various designated users. The cooling towers' performance depends on the weather and the variable needs of the users. At any given time, no more than 60% of the users connected to each cooling tower station are operating. Because the 12 motors used in the four cooling towers (three per tower) are all constant speed, maximum flow is continuously supplied to all users regardless of their need. The plant assessment analysts knew that VSDs could adjust flow based on actual demand and save money by reducing electrical energy consumption and electrical demand charges. The VSDs would also provide smoother control, softer starts, reduced noise, reduced component maintenance, and reduced friction heating of the coolant. Providing 12 VSDs to the cooling towers

Project 3 - Cooling Tower Pumps

to control six 75-horsepower (hp) motors and six 200-hp motors would yield total electrical energy savings of 4.64 million kWh annually (a rough but conservative estimate) and a 10.2-million-pound annual reduction of CO_2.

Project 4—Compressed air system optimization

A limited assessment of the compressor system at the Bayer plant identified one partially loaded compressor that frequently vents up to 500 standard cubic feet per minute of compressed air. This venting occurs when the inlet throttle of the compressor attempts to balance the system supply to the actual plant demand. The WVU team recommended replacing this 800-hp centrifugal compressor with a 400-hp reciprocating compressor. The new compressor would supply the required compressed air flow, but at nearly half the rated power, and no compressed air would be wasted. This modification is expected to yield total electrical energy savings of 1.53 million kWh annually and also reduce electrical demand charges. The reduction in electricity usage will also reduce annual emissions of CO_2 by 3.34 million pounds.



Project 4 - Air Compressor

Project 5—Four low-cost projects

The following low-cost projects each had a payback of 1 month or less:

1) Insulating steam system components including pipe saddles, flanges, boiler end covers, and lines where needed
2) Repairing steam leaks in overhead lines
3) Adjusting the fuel/air ratio in Boiler 7 for a 1% efficiency improvement (based on combustion efficiency tables)
4) Repairing compressed gas leaks (air, NG, and nitrogen).

Repairing the NG leaks alone will save about $321,000 per year. The second greatest savings, $70,000 per year or 14,300 MMBtu/yr, will come from insulating the steam system components. The four low-cost projects together are projected to prevent 95,000 MMBtu/yr of lost heat energy and reduce CO_2 emissions by 11 million pounds annually.

Project 5 - Infrared Images of Steam System Components for Evaluation of Insulation Needs

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Project Partners

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